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# Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

## III SEMESTER B.TECH (CHEMICAL ENGINEERING)

## MAKE-UP EXAMINATIONS, DEC 2015/JAN 2016

SUBJECT: CHEMICAL ENGINEERING THERMODYNAMICS-I [CHE 2104]

**REVISED CREDIT SYSTEM**

Time: 3 Hours MAX. MARKS: 100

**Instructions to candidates:**

- Answer **ALL** questions.
- Missing data, if any, may be suitably assumed.

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| **1A.** | Explain briefly the following with examples:<br>(i) closed and open system (ii) intensive and extensive properties<br>(iii) homogenous and heterogeneous system (iv) cyclic and non-cyclic process | **12** |
| **1B.** | Using the R-K equation, calculate the molar volumes of saturated liquid and saturated vapour of methyl chloride at 333K. The saturation pressure of methyl chloride at 333K is 13.76 bar. The critical temperature and pressure are given as 416.3 K and 66.8 bar. | **08** |
| **2A.** | Discuss with a thermodynamic diagram the variation of molar volume of a substance with temperature at various constant pressures. | **08** |
| **2B.** | An ideal gas undergoes the following reversible processes:<br>(a) From an initial state of 343 k and 1 bar it is compressed adiabatically to 423 K<br>(b) It is then cooled to 343 K at constant pressure<br>(c) Finally, it is expanded to its original state isothermally.<br>Calculate $\Delta U$, $\Delta H$, W and Q for each step as well as for the entire cycle. Assume $C_v = (3/2)R$ | **12** |
| **3A.** | One mole of an ideal gas at $P_1$ and $T_1$ is compressed reversibly and adiabatically to a pressure of $P_2$ and then it is cooled at constant volume till the pressure reduces to $P_1$. Finally energy is transferred as heat at constant pressure till the gas is restored to $T_1$. Derive the expression for net-work done in the simplified form. | **08** |
| **3B.** | State and explain the third law of thermodynamics by giving the statistical explanation for entropy. | **04** |
| **3C.** | Discuss the equivalence of Kelvin and Clausius statement based on heat engine and heat pump. | **08** |
| **4A.** | Derive the expression for first law of thermodynamics for a non-flow process. | **06** |

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| **4B.** | It is planned to maintain a large lecture hall at $25^0$C in summer as well as in winter. The minimum temperature in winter is $3^0$C while the maximum temperature in summer is $40^0$C. The rate of energy loss through the walls and roofing is estimated at 20 kJ/s. Determine the minimum power required to maintain the hall in summer and in winter if the same device is used as a refrigerator in summer and as a heat pump in winter. | **08** |
| **4C.** | Derive Gibbs-Helmholtz equation for the variation of G with T at constant P. | **06** |
| **5A.** | Derive the expressions for showing the effect of pressure and volume on heat capacity at constant pressure and constant volume. | **08** |
| **5B.** | Discuss the air refrigeration cycle with a neat flow diagram and T-S diagram. Derive the expression for coefficient of performance. | **12** |